Forestry Research Progress in 1974 and 1975

Public Law 87-788
87th Congress, H. R. 12688
October 10, 1962

An Act

76 STAT. 806.

To authorize the Secretary of Agriculture to encourage and assist the several States in carrying on a program of forestry research, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it is hereby recognized that research in forestry is the driving force behind progress in developing and utilizing the resources of the Nation's forest and related rangelands. The production, protection, and utilization of the forest resources depend on strong technological advances and continuing development of the knowledge necessary to increase the efficiency of forestry practices and to extend the benefits that flow from forest and related rangelands. It is recognized that the total forestry research efforts of the several State colleges and universities and of the Federal Government are more fully effective if there is close coordination between such programs, and it is further recognized that forestry schools are especially vital in the training of research workers in forestry.

Forestry. Research programs, promotion.

(Sec. 2-6 not included)

"Forestry research."

SEC. 7. The term "forestry research" as used in this Act shall include investigations relating to: (1) Reforestation and management of land for the production of crops of timber and other related products of the forest; (2) management of forest and related watershed lands to improve conditions of waterflow and to protect resources against floods and erosion; (3) management of forest and related rangeland for production of forage for domestic livestock and game and improvement of food and habitat for wildlife; (4) management of forest lands for outdoor recreation; (5) protection of forest land and resources against fire, insects, diseases, or other destructive agents; (6) utilization of wood and other forest products; (7) development of sound policies for the management of forest lands and the harvesting and marketing of forest products; and (8) such other studies as may be necessary to obtain the fullest and most effective use of forest resources.

"State."

SEC. 8. The term "State" as used in this Act shall include Puerto Rico.

Approved October 10, 1962.

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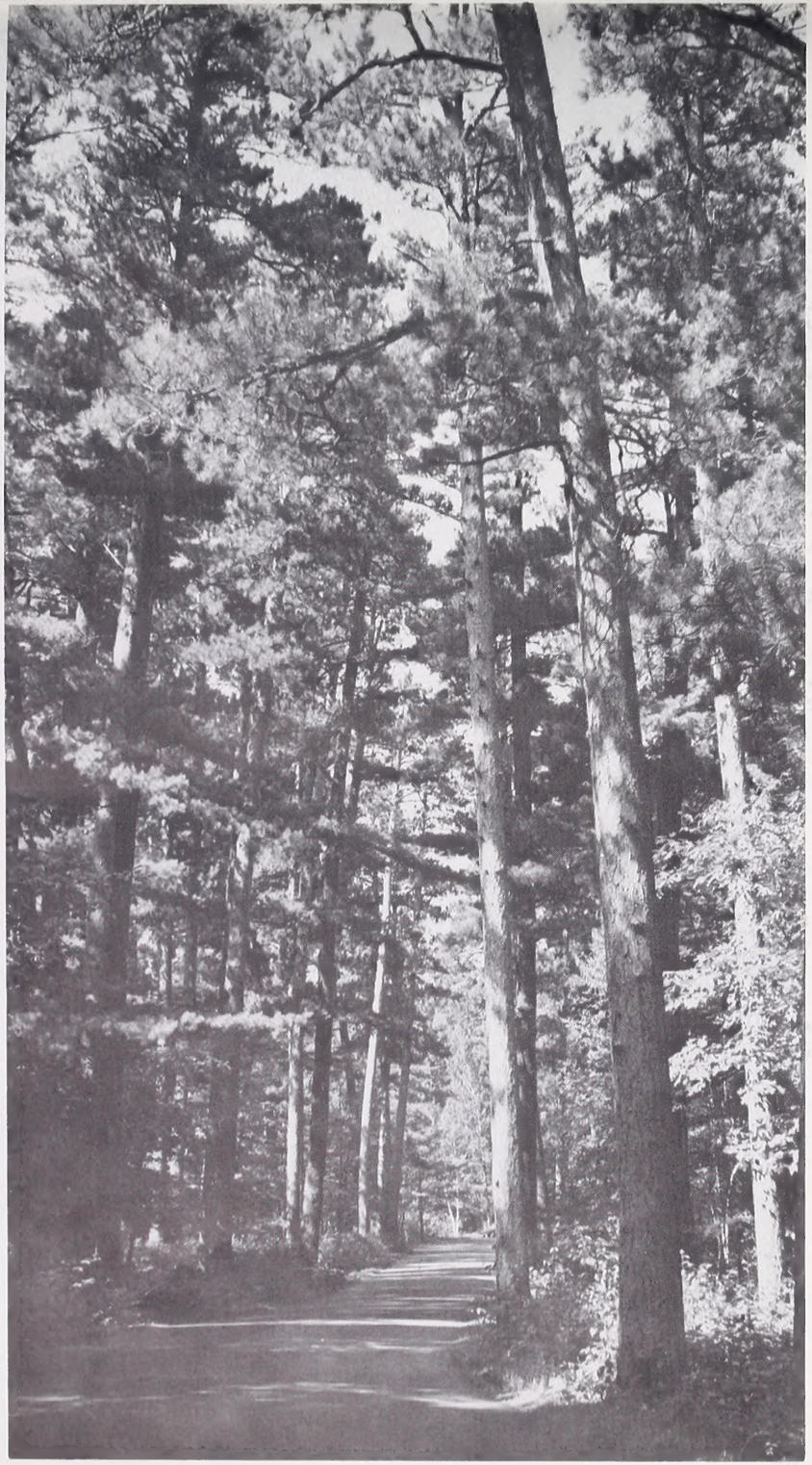


Forestry Research Progress in 1974 and 1975

In line with the stated purposes of the McIntire-Stennis Act, to encourage and assist land grant and other publicly supported forestry schools to conduct research and train scientists in the field, forestry research has made a great deal of progress in the past biennium.

Named for the sponsoring lawmakers, the McIntire-Stennis Act was passed in 1962. It recognized the tremendous importance of research to the protection, renewal and advancement of this nation's precious forest resources.

Today, 62 institutions are cooperating in the McIntire-Stennis program. It is administered through the Cooperative State Research Service of the U. S. Department of Agriculture. Some 640 scientists and 580 graduate students are involved in more than 500 formal research projects.

Two-thirds of these are designed to solve problems and improve the management and protection of forests for timber including harvesting, processing, waste reduction, new product development, and marketing.

The remaining third deals with the management of forests and rangelands for other values—forage for domestic livestock, watershed protection, wildlife, freshwater fisheries, recreation—and with pollution abatement, valuation and land use planning techniques.

In 1974 and 1975, the participating institutions graduated 188 Ph.D's in forestry and related specialties. They are in high demand; 95 percent entered forestry-related employment after graduation.

The program is closely related to and coordinated with research of the U. S. Forest Service. In 1974 and 1975, the McIntire-Stennis institutions, the Forest Service and forest industry were engaged in an extensive regional and national planning effort to identify priorities and strengthen coordination. In addition, the McIntire-Stennis Advisory Committee to the Secretary of Agriculture began its own study to redefine priorities and strengthen the research relationship between all three groups—the Forest Service, forest industry and the public forestry schools. Both efforts are expected to be completed in 1976 and to contribute to the continuing effectiveness of the McIntire-Stennis program.

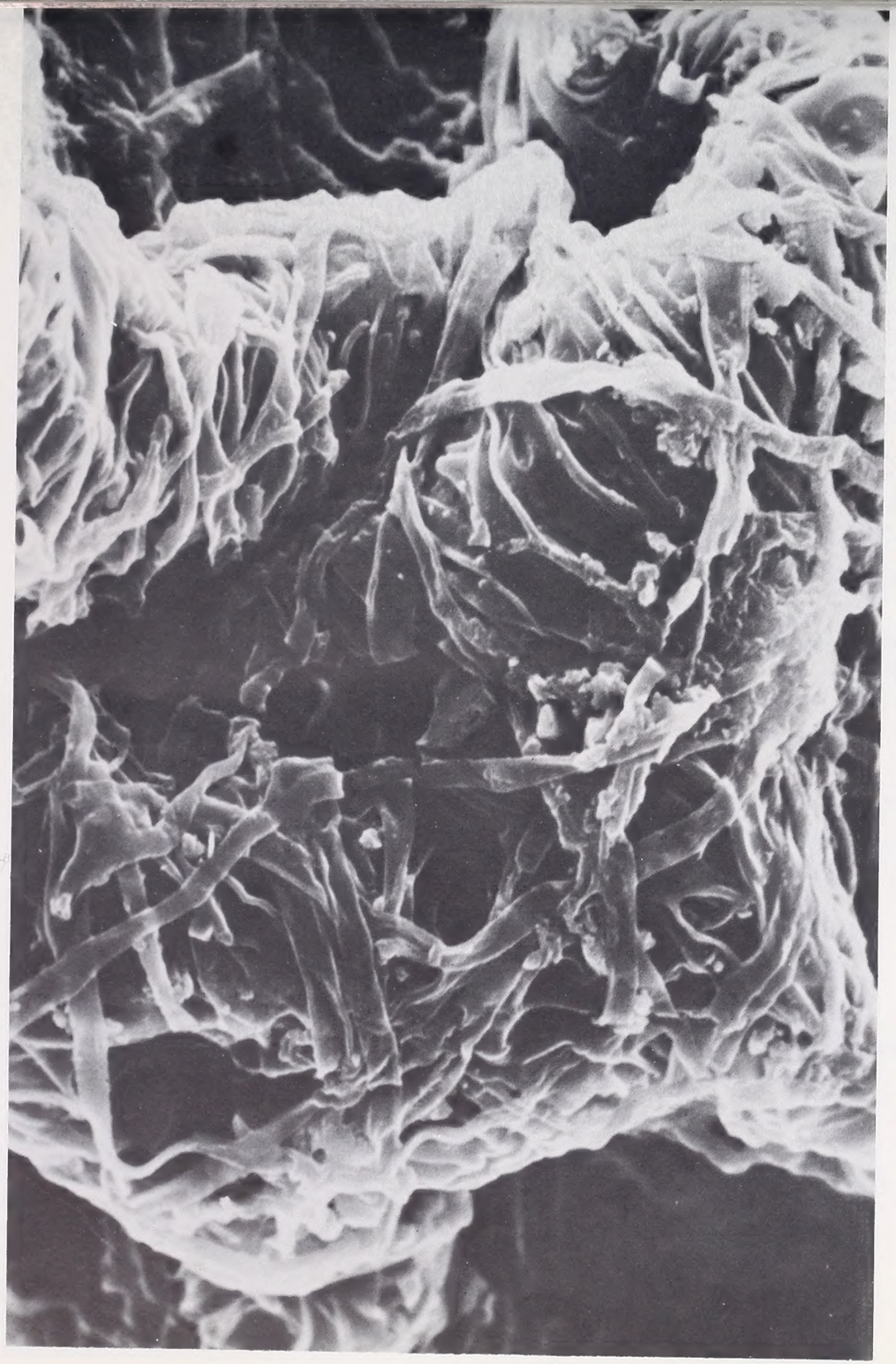
The nation's forests and rangelands today constitute 63 percent of the land area of the 48 adjacent states. They provide a renewable, low environmental impact, largely solar energy-driven base for the perpetual production of a great variety of benefits needed by the United States and the world. These include cellulose, chemicals, construction materials, beef, lamb, wool, water, wildlife and fish, fuel, recreation, environmental improvement and other amenities. Each year, these forests produce 125 million tons of industrial wood raw material, 53 percent of the feed for beef cattle, 60 percent of the water for irrigation, industrial and municipal uses, and are the sites for 624 million recreational visits.

The forest products industries alone employ 7.2 percent of the U. S. manufacturing labor force and produce 6 percent of the value of products shipped.

All demands on these forests and rangelands are expanding rapidly, yet they are producing at only 25 percent of their biological capacity. It is the job of the McIntire-Stennis Cooperative Forestry Research institutions, in collaboration with the Forest Service and industry, to provide through research, the technology to realize the full potential of these extensive and unique renewable resources. If this is done, the United States could become not only the food basket, but also the wood basket of the world.

This report illustrates how the McIntire-Stennis institutions carried out this responsibility in 1974 and 1975.

John Gray, President
Association of State
College and University Forestry
Research Organizations
(ASCUFRO)



About ASCUFRO

This Association was established in 1963. It serves as a vehicle for members to exchange information, form acceptable policies and cooperate in developing and conducting research in the United States. National and regional coordination is provided through membership on the Agricultural Research Policy Advisory Committee's National Planning Committee and liaison membership on the Experiment Station Committee on Organization and Policy of the National Association of State University and Land Grant Colleges. Coordination within ASCUFRO is achieved through four Regional Committees and through a National Executive Committee whose members in 1976 were:

J. L. Gray, President, University of Florida
Donald P. Duncan, Vice President, University of Missouri
Rudy M. Kallander, Secretary-Treasurer, Oregon State University
Fred B. Knight, Northeastern Region, University of Maine
Donald R. Progulske, Northeastern Region, University of Mass.
Lloyd P. Blackwell, Southern Region, Louisiana Tech University
Eric L. Ellwood, Southern Region, North Carolina State University
Mason C. Carter, North Central Region, Purdue University (Chairman of this 1974 and 1975 "Progress Report")
Irving D. Holland, North Central Region, University of Illinois
David B. Thorud, Western Region, University of Arizona
Grant A. Harris, Western Region, Washington State University

ASCUFRO also achieves research coordination through close liaison with the Cooperative Forestry Research Advisory Committee. This was established under the McIntire-Stennis Act to advise the Secretary of Agriculture on this program. The Secretary appoints members. In 1975 these were:

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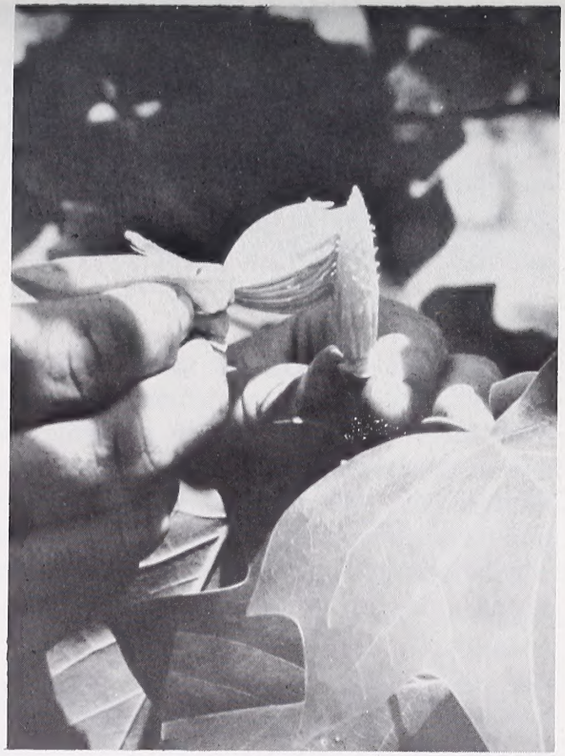

Yellow poplar breeding is receiving major attention in Tennessee and West Virginia.

Black walnut is being improved for both fruit and timber.

Renewing the Timber Supply

In early 1976, in response to the Forest and Rangeland Renewable Resources Planning Act of 1974, the Forest Service presented to the President a renewable resource assessment and a recommended program for the United States through the year 2020.

This report indicated that the demand for wood and lumber products would more than double by 2020, and that this wood supply would have to be derived from a shrinking land base because of the loss of commercial timberlands to urban and recreational development, agriculture and non-timber production purposes. But the report further stressed the fact that timber is one of the renewable natural resources of this nation and the world, and that future supplies can be greatly enhanced through research and development of new technology. Meeting the demand for the future timber supplies of this nation is one of the major challenges facing the forestry research efforts at the land grant colleges and state universities.

New Varieties of Trees

All over the nation forest scientists are following the lead of agricultural scientists in developing new varieties of trees, which produce a far greater quantity and quality of wood than the native wild strains.

Perhaps the greatest success has been achieved in the southern pine region. For example, scientists at the University of Georgia have developed varieties of loblolly pine that produce the same amount of pulpwood in 15 years that formerly required 25 to 30 years. One variety currently under development is growing at the rate of nearly five cords per acre after ten years in the field. This represents an increase of nearly 400 percent over the average growth of loblolly pine in the southern Piedmont and coastal plain. Similarly successful programs of breeding of the southern pines are underway in Florida, North Carolina, Alabama, Texas and Oklahoma.

Intensive breeding programs for Douglas fir in the Pacific Northwest are in progress. Scientists in Idaho and Montana are developing new varieties of Ponderosa pine, while lodgepole pine is the center of attention in Colorado. From Maine to Minnesota, tree breeding programs for white pine, white spruce and balsam fir are being conducted by state universities.

While the conifers have certainly received the major emphasis in most tree breeding programs, an extensive effort is also underway in the breeding of a wide variety of native hardwood species. New varieties of cottonwood are being developed in Oklahoma, Louisiana and Kansas. Sycamore breeding programs are well advanced in Georgia, North Carolina and Mississippi. Minnesota, Michigan and Wisconsin are working to improve the performance of native aspen, while Maine and Ohio have breeding programs in birch, ash and oaks. The native oaks and yellow poplar are receiving major attention in West Virginia and Tennessee, while Indiana, Illinois, Kansas and Missouri, the prince of American hardwoods, black walnut, is being bred for both timber and fruit production.

A number of other species are included in breeding programs, and timber production is not the only objective being pursued. Many states are developing new and improved varieties for Christmas tree production. Adaptability to submarginal environmental conditions, such as strip mined areas or areas of high atmospheric pollutants, is being sought in some states. In summary, tree improvement research is now or soon will be providing the forester, the landscape planner and the private landowner with a wide selection of improved varieties of trees to better meet the demands for future timber supply and to improve the quality of man's environment.

Intensive Culture Methods

To achieve the maximum productive potential of the new varieties of forest trees and of existing wild varieties, considerable research effort is being channeled toward intensive cultural methods. Pioneering efforts in forest fertilization carried out in Florida, Washington and New York have demonstrated that prescription application of fertilizer can improve the productivity of forest lands from 20 to 250 percent. These early results prompted a major increase in research effort in forest fertilization and mineral nutrient cycling in the forest ecosystem. Scientists from Alaska to Florida are investigating the movement and distribution of nutrients such as nitrogen and phosphorus in the undisturbed ecosystem and following harvesting or external application of nutrients.

In several states, most notably Georgia, Iowa and Kentucky, scientists at McIntire-Stennis institutions are investigating the potentials for large quantities of wood fiber produced on short rotations with hardwood tree species planted at close spacings and grown and harvested similar to a silage operation. Following harvest, these species resprout from the stump and produce a second crop in two to five years.

In this operation, stem, bark, branches and leaves are utilized, and a very high level of dry matter production is achieved. Such intensively cultured plantations show great promise for meeting the needs of certain types of manufacturing facilities and as energy plantations in certain applications. Irrigation, fertilization and weed-control techniques are adapted to this type of culture, as well as the selection of tree varieties that are suitably adapted to the technique. A variety of research problems and projects has been spawned by these discoveries.

Natural Stands and Small Ownerships

If the future wood needs of this nation are to be met, a major contribution must come from small, privately owned, non-industrial woodlands where the terrain, ownership pattern or available capital may not permit intensive cultural practices to be applied. But these stands and woodlots have considerable potential for increased productivity through the development and dispersal of knowledge designed specifically for such ownerships.

Land grant colleges and state universities have a long history of concern for and a close working relationship with the small, private landowner; and considerable effort is being made by the McIntire-Stennis institutions toward obtaining new knowledge that can be useful in increasing the productivity and profitability of small, private woodlands.

University scientists in Oregon, New Hampshire, Michigan and Mississippi are exploring the economic and social factors which influence the decision-making process of small woodland owners, so that recommendations for improved forest management can be designed to meet their interests and capabilities. In Alabama, South Carolina, Ohio, Minnesota, Illinois and West Virginia, scientists are experimenting with methods of managing and protecting natural stands of native species under the constraints typical of the private landowner.

Modeling and Simulation

By nature, forest research, which deals with the growth and development of trees, is a long-term undertaking. But the development of computer-assisted, mathematical simulation techniques is helping forest scientists to evaluate an enormous amount of data, discriminate between a variety of alternatives, understand the interaction of many diverse environmental factors, more accurately forecast yield, and to optimize management techniques to meet a wide variety of objectives.

Simulation models for pine and Douglas fir plantations have been developed in Georgia, Virginia, California and Washington. While scientists in Missouri, Wisconsin and Indiana have developed mathematical models of hardwood forests. In Michigan and Minnesota, scientists have developed economic analysis techniques which greatly assist the forest landowner in optimizing the return from his investments. Most of these programs consider not only timber production, but wildlife, recreation, water yield, aesthetic and other values as well, depending upon the interests and the objectives of the owner.

Basic Research

Any major biological research effort should consist both of studies designed to solve immediate existing problems and more fundamental investigations exploring the unknown aspects of the basic life processes. This fundamental research will provide information to solve not only the problems of today, but perhaps avoid or better cope with problems which may arise in the future. The universities cooperating in the McIntire-Stennis program are conducting a variety of such basic research projects.

Basic investigations in the physiology of flowering are taking place in a number of states. Early, prolific flowering is a principal goal in most tree improvement programs; and researchers hope some of the current research into the initiation of the flowering process will provide the key to increased floral initiation and development.

In Oregon, scientists are studying the photosynthesis, transpiration and root growth potential of Douglas fir to better understand the behavior of the species. Membrane and protein biochemistry is being investigaged in Missouri in an effort to understand winter hardening and dormancy characteristics of trees. In Maryland, New York, Connecticut and Missouri scientists are exploring the basic relationships between soil fungi and tree roots to understand why some species appear to be much more efficient in extracting moisture and nutrients from the forest soil.

In several states, scientists are deeply engaged in investigations of the use of tissue culture to propagate forest tree species. The successful conclusion of these studies could mean a revolutionary breakthrough in the selection, propagation and development of improved varieties of trees, as well as contribute considerable information to the storehouse of knowledge about the basic principles of plant growth.

—Mason C. Carter
Head, Department of Forestry
and Natural Resources
Purdue University

A pressure chamber measures the internal moisture stress of a Western Hemlock seedling. This research is part of a project to study environmental factors which influence root growth, being conducted in Oregon.

Improved management practices, especially fertilization, show obvious benefits. This five-year old stand of slash pine was fertilized with 40 lb. N and P at time of planting.

Range and Wildlife Management

Research in the area of managing forest forage and wildlife represents a substantial effort by the participating McIntire-Stennis institutions.

Forage and Range Research

Vast areas of the western United States are covered with pinyon-juniper, oakbrush or chaparral. While these cover types have limited value for commercial forest products, they are collectively more extensive than any other cover, and they often have high value from the standpoint of multiple use forestry. In some cases, they provide posts, poles, mine props and specialty products, like pinyon nuts. Very commonly they provide forage for domestic livestock and very important winter range for forest wildlife, and in their environments, they are regarded as having high aesthetic and watershed values.

Largely non-commercial forests of pinion-juniper and oak brush provide invaluable wildlife habitat.

Studies are underway at several institutions to find ways to better utilize and manage these woodland types. Colorado State University has found that applying herbicides and mechanical controls to oakbrush woodland-rangelands can provide significant increases in forage for beef production. New Mexico State University investigated the effects of fertilization on growth and deer use of browse species in pinyon-juniper woodlands. Early results indicated both increased growth and higher amounts of crude protein in both juniper and oak species.

University of California research on chaparral-grasslands is concerned with some of the effects of brushland conversion on forage production and composition.

Preliminary results of an Oregon State University investigation on controlled sheep grazing and Douglas fir establishment indicate that spring grazing by sheep severely reduces height growth. Sheep repeatedly browse the new terminal and lateral shoots. However, initial survival of seedlings was apparently not affected significantly by browsing or by transplanting.

The University of Florida is conducting a study on the management and use of forested rangelands. Increasing intensity of site preparation following clearcutting appears to result in lower grass densities but has little affect on forbs. In another study in the south Florida Flatwoods range, chopping of shrubs and palmetts with subsequent fertilization yielded substantial increases in grass and herbage production.

Wildlife and Wildlife Habitat Investigation

Wildlife continues to be a popular research area. Among the wildlife habitat projects, the white-tailed or mule deer is the subject of fully half the total research effort. Of the 36 institutions reporting, all but three have ongoing research in the wildlife-wildlife habitat area.

Non-game birds in forest environments are the subject of work at Michigan Technological University, the University of Maine and Louisiana State University. The Michigan study is assessing habitat modification of the forest environment—including introduction of watering devices and nest boxes. Initial studies in an uncut area, directed principally to the marten, indicated the presence of 31 bird species during the June breeding period. Selective cutting is planned to assess its impact on the distribution and abundance of the marten and associated species. The Louisiana study is attempting to measure winter bird populations (both overwintering and visitor species) in a pure 45 year old loblolly pine stand.

Ruffed grouse, quail and wild turkey and their habitats are under investigation at the University of Georgia, University of Tennessee, University of Michigan, University of Montana and North Carolina State University. These studies include drumming observations in different habitats, food, winter habitat, hunter impacts, nesting habits as well as population levels and distribution of these game birds.

Forest management practices and their effects on wildlife are currently receiving more attention than any other specific research area. The majority of these studies is concerned with impacts on deer, but other wildlife species are included in some of these studies. Studies are underway at Oklahoma State University on the compatibility of game and timber production on intensively managed lands and on wildlife and pine clearcut relationships. These studies include plant succession, grass, forb and browse production and use by wildlife.

Forest wildlife habitat changes resulting from land management or manipulation are under investigation at the University of Kentucky, Virginia Polytechnic Institute, University of Georgia and Cornell University.

Park-like forest-grassland ecosystems provide a pleasing landscape and invaluable wildlife habitat, wildlife winter range and high value domestic grazing.

The New York study is concerned with habitat changes resulting from the revegetation of abandoned farmland. Current measurements will be compared with 1930 data. The Virginia study is a long-term, large-scale study involving a variety of wildlife and habitat changes. For instance, they found that clearcut openings are used by woodpeckers for feeding and nesting. Also that fall orphaning of deer fawns did not adversely affect the fawns in that they were able to survive and were accepted into the deer social structure, and chasing deer with dogs in open country during gestation did not affect reproduction. Dogs were unable to catch healthy deer.

The University of Georgia study is also a large scale study involving deer, raccoons, fox, bobcat and opossum. Sub-studies of this project include the predator role of the bobcat in the forest ecosystem, succession of small mammals in young pine plantations and seasonal movements of whitetailed deer in relation to land management practices and hunting pressures.

Mississippi State University and University of Michigan studies are concerned with forest cutting methods and stand conversion on deer food production. The University of Montana is using radio collars on elk to relate elk movement patterns, activity and habitat use on logged areas of the Sapphire Mountains.

Roads and powerline rights-of-way and their effects upon wildlife are under study at the University of New Hampshire, Colorado State University and West Virginia University. The New Hampshire study indicates greater wildlife use of selectively cut powerline rights-of-way as contrasted to clearcut openings. The difference appears to be related to the greater vegetation species diversity on the selectively cut areas. The West Virginia study will assess changes in wildlife abundance and movements before and after interstate highway construction.

Rutgers University is conducting a study on the attitudes, motivations and perceptions of outdoor experiences of New Jersey hunters. Based on studies in controlled access areas, there is an apparent desertion from hunting, and a growing anti-hunting attitude developing in New Jersey.

Radio transmitters are being used on bear to measure their movements and activities in the Great Smoky Mountains National Park by scientists at the University of Tennessee. Their studies include evaluations of food habits and populations of gray fox, bobcat and raccoons. The lowland hardwood forest in southeast Missouri provides the site for wildlife studies underway at the University of Missouri.

Vegetation composition, density and structure, as well as climatic and animal trapping observations, are included in the study. The University of Vermont is attempting to measure the seasonal carrying capacity of spruce-fir-northern hardwood forests for deer through food habits study. Radio transmitters are also in use on deer and wild turkey to measure use by these animals of cottonwood plantations in Mississippi. Mississippi State University is conducting this study.

—Robert E. Dils
Dean, College of Forestry
and Natural Resources
Colorado State University

Logging residue produced in cable-assist falling in Oregon was significantly less than that for conventional falling.

An experimental floor decking constructed of particleboard and southern pine veneers was found by Alabama researchers to offer advantages over conventional floor construction.

Utilizing Wood Resources

Current and projected shortages of natural gas, fuel oil and petrochemicals have focused attention anew on the forest as a source of fuel and raw materials for the chemical industry. These uses, both real and potential, coupled with the long-term increases in demand for wood residues for board products, hold promise of both higher levels of utilization of mill residues and development of non-traditional sources of residue. Logging slash and cull or low-grade hardwood trees will undoubtedly be important in the latter respect.

Wood as a Chemical Feedstock

Wood is no stranger to the chemical industry. In years past it was an important source of such basic industrial chemicals as acetic acid and methyl alcohol. In modern times, wood's uses as a chemical have increased in both number and sophistication. Today, it accounts for a significant part of the synthetic fiber industry, an impressive fraction of the plastics industry, and virtually all of the pulp and paper industry. It is technically possible, according to scientists in North Carolina, to derive 95 percent of the output from wood, an amount equivalent to 34 billion pounds.

Scientists in several states are exploring the production of resin adhesives from bark to supplement the supply of petroleum-derived phenolic resins. Results are encouraging. In Colorado, experimental particleboard panels bonded with bark extracts containing a coupling agent met minimum requirements for all strength properties except internal bond. Similar work in California produced panels that met standards for commercial exterior-type particleboard. Other research on the chemical utilization of bark is being conducted in Mississippi and Oregon.

Conversion of wood to useful chemicals has attracted the attention of researchers in a number of states. California scientists are studying a pyrolysis-gasification-combustion process for producing methyl alcohol from wood. In Texas, enzymes isolated from common fungi are being used to catalyze the breakdown of wood residues to glucose at a rate many times faster than that achievable by conventional hydrolysis techniques. Both processes have the potential of utilizing the vast quantities of mill residues and low-quality trees to produce a broad range of chemicals now obtained from petroleum.

More than 200 million board feet of timber are removed from forest lands in the Pacific Northwest each year. Oregon research is helping to identify the costs and fuel consumption of helicopter logging.

Particleboard is finding new uses for subflooring, sheathing and siding, as on this Minnesota house.

Reconstituted Wood Products

Consumption of reconstituted wood products has increased at a rapid rate during the past decade—20 percent per year since 1964 in the case of particleboard. Continued growth of the market for these products is virtually assured because of changes in timber supply and quality. Since the properties of reconstituted wood products are independent of timber quality, particleboard and related products can be manufactured from materials unsuited for other uses, thus increasing the apparent supply of wood.

The advantage of particleboard-related products over lumber and plywood in terms of raw material quality requirements has stimulated research by scientists in many states. Most of the research is directed toward improving existing products, determining the effect of various types on board properties, and characterizing particleboard and fiberboard in terms of mechanical properties.

Work in this area is of particular importance because of the probability that the use of particleboard in a load-bearing capacity in construction is on the verge of rapid expansion. Impact loading and long-term loading studies, and tests on the use of particleboard as webbing in composite beams are being conducted by scientists in Minnesota, Maine and Indiana. Also, work in Alabama has dealt with development of particleboard-veneer composites for use as floor decking.

Researchers in California, Oregon, and Virginia are exploring the use of bark, logging slash, and other types in board products. Their work shows that a wide variety of types, including the bark of some species, can be used successfully in particleboard.

Logging, Milling, and Processing

Logging and milling costs represent a significant fraction of the selling price of lumber and have been increasing steadily for years. Progress on methods of increasing the efficiency of these operations has been reported by several states. For example, a light-duty sky-line logging system for Appalachian-type terrain increased production rates, while reducing site damage in tests in Indiana. Scientists in Louisiana are studying the feasibility of using balloon logging in southern wetlands, while in Oregon, comparisons of conventional and cable-assist falling revealed that the higher cost of the latter was offset by lower incidence of breakage and a reduction in stream cleanup costs from less logging slash.

In Mississippi simulated sawing of pine logs using a chipping headrig revealed that sawing pattern and circumferential position of the log can affect lumber value by as much as 43 percent. Logs of all grades were found to have an optimum position entering the saw that produced the maximum lumber value. In a similar study in Kentucky, it was found that lumber value from live sawing of hardwood logs up to 30 inches in diameter was higher than that for conventional four-sided sawing. These results were later verified in mill tests of oak logs up to 24 inches in diameter.

Researchers in several states, including California, North Carolina, New York, and Colorado, are involved in pulping studies designed to increase yields, reduce pulping times, and eliminate the odor problem associated with kraft pulping. Results are encouraging. For example, processes under test in California hold promise of reducing pulping time by about 30 percent, reducing refining time and energy requirements, and increasing yields by as much as 5 percent, compared to conventional kraft pulping. The mechanical properties of pulp produced in this study are also reported to be favorable.

Work in North Carolina and New York on non-sulfur pulping techniques also holds promise of increasing pulp yields and, simultaneously, solving the odor problem that is a feature of such pulping techniques.

A somewhat different approach to this problem is being used by Colorado scientists. In their process, lignin is modified preparatory to chemical pulping. The process is malodor-free and is reported to produce light-colored pulps of exceptionally high yields that have strength properties which are, with the exception of tear, higher than those for kraft pulps.

—Warren S. Thompson
Director, Forest Products
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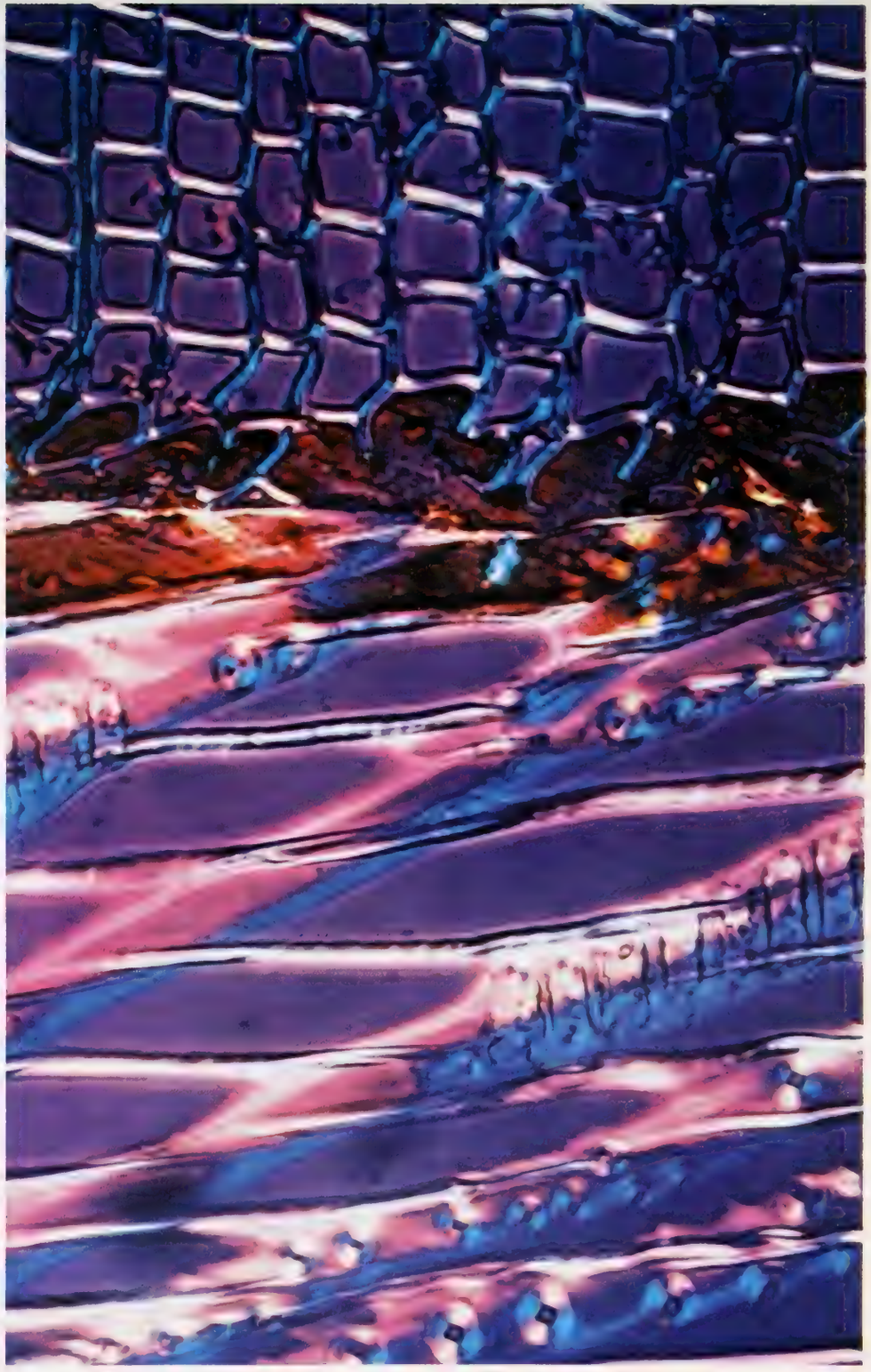
Mississippi State University



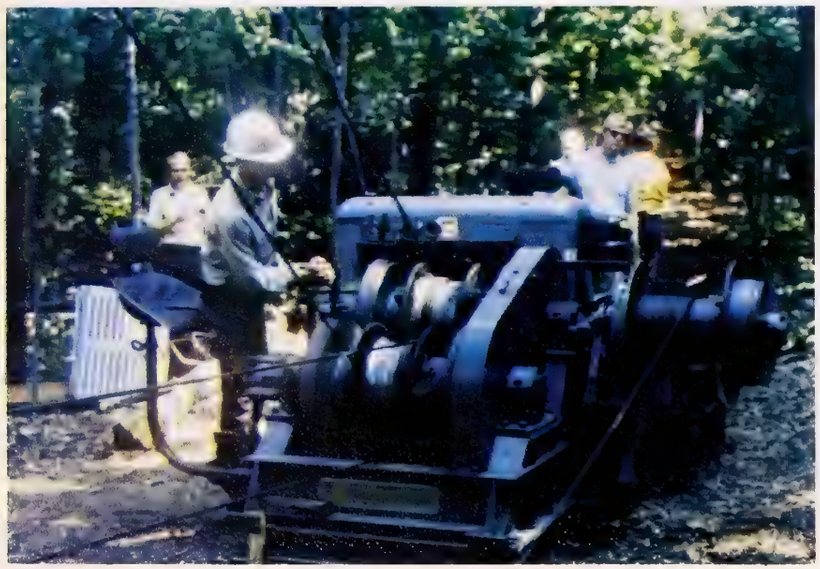
Microscopy is a valuable analytical tool, in this photo of the glueline in experimental plywood under study in Maine.

Studies in Mississippi of the biological treatment efficiency obtained with wood-preserving wastewater using a pilot trickling filter, provided the design parameters for full scale pollution control equipment.

Truss designs developed in Indiana are used nationwide.

Tests of the stresses imposed on poles in accidents involving farm machinery are being conducted in Mississippi.

Production rates obtained with this light-duty skyline logging system designed in Indiana were greater and site damage less than with tractor logging.



The mechanics of paint failure and useful service life of many other commercial products, such as these paints and stains, are being studied in Mississippi.

In Rhode Island, studies of compacted soils in recreation areas measured root starch levels as indicators of tree stress.

Fire is being introduced as part of the Itasca park management plan in Minnesota to help reconstruct the pine forests.

Forest Recreation

For many Americans, the forest is an increasingly important source of recreation. Since World War II, the number of visitors to forests for recreational activities have more than quadrupled. Aesthetic environments for hiking, hunting, bird watching, skiing, canoeing, fishing, camping and picnicking are seen by many citizens as major forest values.

The role of the forest as human environment has assumed a primary role in shaping American forest policy. With these developments has come a variety of problems and research studies relating to conflicts among uses, carrying capacities, visitor perceptions and preferences, the role of private ownerships, problems of pollution, and other concerns.

Assessing Recreational Use as a Basis for Management

A quantitative analysis of wilderness use levels in California has demonstrated the importance of size and elevation of the areas, travel time from metropolitan areas, population within 100 miles, and number of lakes or entry points. One of the untimate aims in this research is forecasting future use levels.

In Michigan, a study attempting to provide guidelines for maximizing satisfactions derived by trail hikers demonstrated highest levels of enjoyment (as measured by time spent) at those areas providing environmental discontinuities, such as forest-meadow border. And, in the Mogollan Rim area of Arizona, studies of recreational activity preference provide managers a basis for differentiating between conflicting and compatible activities and for planning for low-cost recreational use with fewer types of activities.

In New Mexico, costs associated with recreational use of the Sandia Mountains were assessed. Control of pollution associated with recreational use in 1973-74 would have been about $326,000. Assessed against the appropriate class of user, these costs ranged from $0.03 to $0.28 per hour of use. Twenty pollutants were identified; and litter, wildlife harassment, fire prevention and control, crowding, aesthetic deterioration, and noise rated highest in cost based on the ability of the Sandias to absorb or modify them. In this grouping, crowding and wildlife harassment were far more costly to control than littering.

At Itasca State Park in Minnesota, a major research effort has concentrated upon management objectives and techniques for the park's vegetation. They concluded that to re-establish the park forest in its presettlement condition, active management must replace past protection-oriented management. For instance, large old red pine stands originating after fire must be protected against porcupines and other damaging agents. Drastic action is required to convert present aspen stands to their original pine. Early results indicate that competition from aspen suckers and shrubs and heavy mortality from concentrated deer browsing are major obstacles to such conversion.

Role of Private Lands

There is growing interest from various governmental organizations in opening private land to recreational use. Fee simple purchases by public agencies under spiralling land costs cannot meet demand. However, the receptiveness of private landowners to public access is not well-explored.

Private owners of small forested tracts on the urban fringe have been the subject of a Michigan study. Their willingness to permit hiking, hunting and snowmobiling and their attitude toward public access were investigated. Half the owners had their land for amenity values; the majority hiked on their land, but few hunted or snowmobiled. Over one-third of the lands were posted against hunting. The majority of landowners in this study would allow all three uses on request with reasonable payment for the privilege. Those who indicated refusal of access cited "damage" as their reason. Control, liability and numbers also are important issues.

In Louisiana, large (more than 5,000 acres) private land ownerships exceed six million acres totally, representing a ten percent loss during the past decade (largely through conversion of forest to soybeans). But more than three times as much land in this class (compared to ten years ago) is now leased for recreation (usually to hunting clubs) or open to the public. Both industrial and nonindustrial lands are included.

—Donald P. Duncan
Director, School of Forestry
University of Missouri

Hunting and other recreation are available to the public on 83 per cent of large private forest ownerships in Louisiana.

Suspended sediment monitoring in Oregon has helped measure the impact of logging and road building on water quality.

Water quality samples in the Missouri Ozarks are helping to define the capacity of forested watershed to renovate sewage.

Small watersheds in Georgia have been instrumented to measure water and sediment delivery from clearcut areas.

Understanding the Water Resource

Substantial progress has been made in McIntire-Stennis research which focuseses on the processes that control the movement of water into, within and from forested watershed. An understanding of the basic principles of hydrology is necessary for using forest resources wisely and to solve problems of water quality.

Forest Hydrology Research

A great deal of research effort has been devoted to the accumulation of baseline data and the development of modeling techniques for watersheds. For instance, land managers in the Georgia Piedmont now have baseline data from watersheds covering eight years, including such characteristics as stormflow, peak discharge, total flow, low flow and sediment delivery. This is accompanied by environmental data also.

Modeling the outputs of experimental watersheds in Utah has improved understanding of storm runoff, and has yielded new methods for predicting runoff.

The stability of forest soils in relation to infiltration rates was studied in the Oregon Cascades and in Maine, and the results of such studies promise to be useful in the development of management programs.

The climatic characteristics of the forest were found to reduce the melting of the winter snowpack. Clearcutting in Pennsylvania, for example, significantly increased the daily peak runoff rates. Comparisons made in New Mexico suggested that evapotranspiration for forests was greater than for grasslands during an extended spring drought. And a Massachusetts study is helping to define the decrease in water yield that is associated with the re-establishment of forests upon abandoned farmland.

Water Quality Research

Advances in water quality research were made in two areas. The first is the development of understanding of the characteristics of runoff from forested watershed, and the second is recognition of the promise offered by the hydrologic characteristics of the forest to help solve the problems of

liquid water disposal. In other words, understanding why and how the forest deals with water movement, absorbtion, evaporation and transpiration will enable researchers to devise improved management techniques.

An Oregon model predicts reasonable values for changes in dissolved oxygen associated with the accumulation of logging slash in small streams. It has been found that oxygen depletion is closely associated with temperature changes when clearcutting exposes the streams. Higher temperatures reduce the oxygen saturation values and increase the rate at which materials are leached into the stream. Logging slash in spawning beds has only recently been recognized as a problem.

A West Virginia study has found that temperature measurements in streams can be expedited using inexpensive chemical integrators. They found that a buffer strip is important in controlling stream temperature increases, as the rise in temperature associated with clearcutting went as high as 20° F.

The capacity of the forest to purify liquid wastes is becoming increasingly recognized. Adequate renovation of sewage is being achieved in the Missouri Ozarks. Spray application of sewage in Georgia also confirms the large capacity of sloping forest land to effectively remove pollutants. In this study, only one pollutant was detected in the outflow and it had been reduced to 10 percent of its initial concentration. In another study, a synthetic waste water containing 8 ppm soluble phosphorus was applied to six diverse Connecticut soils. While P was absorbed heavily in acid soils, wetting-drying cycles were found to regenerate the absorption sites. This regeneration extended the effectiveness of the soil filter.

The renovating capicity of natural watersheds was further confirmed in Utah, where no significant differences were found in waste concentrations in surface runoff from grazed and ungrazed areas. Tests are being designed in Illinois to apply concentrated liquid wastes from cattle feedlots to forested and to agricultural watersheds, to develop improved waste disposal practices.

Land Rehabilitation Research

Progress is reported from Washington in the development of emergency revegetation techniques for watersheds denuded by wildlife. The results from five years of plot studies confirm the necessity there of herbicide application for successful broadcast seeding of burned rangelands. Sherman big bluegrass consistently showed the best establishment, provided that litter had been removed by the fire, and that the treatment was applied in the February to early March period. Best results occurred when seeding took place immediately following herbicide application.

Increasing activity in coal mining has generated greater interest in reclamation as a means of minimizing damage from mining wastes. Researchers in Pennsylvania have sought to identify and adjust conditions that prevent easy reclamation of wastes. Red pine and European white birch seedlings readily survived on anthracite wastes, when planted with a mulch and lime-plus-fertilizer treatment. The Pennsylvania study also identified a number of grasses, forbs, and sedges that could tolerate aliminum concentrations as high as 120 ppm. In general, species that were tolerant of adverse environmental conditions on acid soils were also tolerant of aluminum.

Field trials of revegetation of coal surface-mined lands in Alabama indicate that the growth of fertilized plantings of sycamore and catalpa was substantially greater than that of unfertilized loblolly and slash pine. Examination of wildlife usage of the naturally revegetated mine areas showed that bird density decreased as the mines aged, and species diversity also decreased. A West Virginia study of wildlife usage on strip mined areas has helped define the use patterns of species ranging from sparrows and grouse, to deer and foxes.

Aquatic Environment Studies

Timber harvesting, forest road construction and their impacts on fish habitat are receiving increasing attention from resource managers and the general public. One of the often heard criticisms of forest harvesting is that erosion and sedimentation lead to lowering of water quality and the aquatic habitat. Many institutions are directing a variety of research attention to these problems.

The University of California is examining the influence of protective streamside buffer strips in logged areas on aquatic organisms. This new study will compare results from protected and unprotected streams as well as testing sampling techniques. Another California study is attempting to measure forest vegetation and its litter production as a source of energy in logged and unlogged watersheds. Early results indicate lower energy supply to streams from clearcut Douglas fir and second growth areas than from unlogged waterbeds.

At the University of Georgia, a somewhat similar study to assess various forest management practices on fish production (biomass elaboration) from streams within national forest boundaries is underway. Louisiana State University is studying bird populations and their distribution in the seasonally wet bottomland hardwood forests.

In the northeast the fisher is a common inhabitant of the forest aquatic environment. Studies at the University of Vermont are directed to the occurrence, growth and behavior of this important fur bearer. The wood duck, another forest aquatic environment inhabitant, is the subject of projects recently initiated at the University of Tennessee and at Louisiana State University. These studies center around the distribution, population dynamics and ecology of the wood duck in forest covered river edges and impoundments.

The University of Idaho is evaluating methods for increasing native cutthroat trout in the northern forested watersheds. Results to date indicate that temporary closure of heavily used streams to fishing does indeed increase fish populations. Closure of remote areas of the stream has little impact on populations, largely because they are apparently already well-stocked. To fishermen it should come as no surprise that their creel census studies indicated that catch rates in inaccessible zones of streams were nearly six times as great as those in accessible areas.

—David B. Thorud
Head, Department of Watershed Management
University of Arizona

This deep-cut mine is in dire need of reclamation.

Hemlock scale is being studied in Connecticut. Here an entomologist examines a sticky plate for crawlers.

The relationships of weather factors, tree vigor and the biology of the roundhead pine beetle are being studied in New Mexico.

Protection from Insects and Disease

Insect and disease losses continue to be major problems for forest managers. The damage to timber, aesthetics, recreational opportunities and watersheds can periodically reach catastrophic levels. Often, these losses are due to natural components of the forest ecosystems, but sometimes management methods may also create serious problems, and some damage may be due to introduced organisms.

The goal of research is to provide basic information and techniques so land managers may reduce losses to the lowest levels possible within economic reality. Research is centered on the forest itself and is all directed toward keeping destruction at a minimal level. However, losses continue at levels far greater than this nation can afford in light of the long-range forecasts of needs.

Defoliating Insects

Many species of insects cause serious growth losses and death of trees by direct feeding on the leaves. Scientists are continuing their efforts to develop better ways to combat these pests. In Wisconsin a study on the causes of differences in feeding by sawflies on pine needles of various stages in maturity is in progress. Four compounds with strong deterrency to sawfly larvae have been isolated from juvenile pine needles.

The spruce budworm has been present in massive numbers for several years through Eastern Canada and the spruce-fir forest ecosystems of the Northeastern states. Scientists have been working on several aspects of the problem including direct control and population ecology. Sampling procedures for more accurate measurement of insecticide effectiveness and parasite monitoring have been developed. Studies of new procedures for prediction are also being investigated. Additional parasites have been released and evaluations are continuing in the release areas.

The gypsy moth continues to be a major problem over a fairly large portion of the country. Studies have continued on defoliation and resultant tree mortality in Connecticut. Tree mortality in Rhode Island was most severe in white oak of the intermediate and suppressed crown classes. Radial growth loss was apparent on oaks in all defoliated stands.

Hylobius pales feeds on the bark of newly planted pine seedlings. This pest, which causes reduced stocking and plantation failure, is being studied in the Southeast.

Dendroster sulcatus, an important parasite of the southern pine beetle, forms its cocoons in the larval galleries and emerges through holes in the bark.

Tests were continued with a pheromone attractant in a microencapsulated formulation. Test results were impressive in that female gypsy moths in treated test plots were not mated. Studies of gypsy moth behavior also revealed that late stage larvae move in a straight line using polarized light for orientation. Larvae respond to vertical objects along the general path of travel. Very little movement takes place around noon when polarized light is weakest.

Beetles continue to be the major cause of mortality in coniferous forests. They have always been difficult to control because of their habits and their association with other poor conditions in a stand of trees.

Research in New Mexico on the bark beetle has been centered on the biology and control of the insect pest. Annual measurements on 350 plots have been designed to correlate infestations with prevailing weather and soil moisture. Several insecticides applied in oil dilution showed promise for control.

A study on the use of cacodylic acid was terminated in Colorado where the material was being tested for "lethal trap trees" to use in beetle control. Significant differences were found between treated and untreated Engelmann spruce trees.

The southern pine beetle has been subjected to a very large research program in Georgia for several years. Scientists studying ecological aspects of the pest problem have determined that several expanding generations are required for the development of a medium to heavy population. In the spring there must be a moisture deficit or a small overwintering population will not increase. Research on mass attack by this insect related to the effect of pheromones on the process.

Other Insect Pests

There are groups of insects causing severe damage in all sections of the country that are neither defoliators nor bark beetles, though their effects may often be similar. Meristematic insects feed upon the growing tips of the tree. The white pine weevil has long been a severe pest to the extent that, in some sections, the tree is not planted despite its superior growth qualities and the high value of the wood. This insect is also a serious pest of Sitka spruce on the west coast. Studies at the University of Washington have shown evidence of a pheromone in the females of the insect. Research on tree resistance provided proof that Sitka spruce near the coast were resistant, while those at inland sites were attacked.

Two additional weevils received attention in Georgia. Respiration rates were studied and both *Hylobius pales and Pachylobius picivorus* demonstrated a reduction of oxygen consumption.

Seed and cone insects have caused problems in all sections of the country and on a wide variety of tree species. Damage by black walnut curculio has been effectively reduced by the use of insecticide application timed to adult emergence. This research was done in Missouri.

In Idaho, the bionomics of cone and seed insects of Ponderosa pine were investigated to anticipate their effects on seed orchards. Researchers found that seed orchards should be located away from host plant forests and should be in mixed forest types with different species composition. The cone insects of the genus *Dioryctria* have been of consequence throughout the South. Insecticide granules applied to seed orchards in Mississippi were found to be effective in control of the problem.

Another group of tree pests are those which suck the juices; and, in Connecticut, the red pine scale has been investigated to determine the effects of temperature regimes on their distribution and spread. Cold temperatures apparently prevent the spread of the pest to northern areas. Several insects were investigated in Ohio to determine the effectiveness of systemic insecticides applied as granular formulations.

Diseases

Forest pathogens and other causes of physiological stress in trees are ever present and continue to be the major source of growth loss in the forest. Much work has been done to develop resistance to some of the disease problems by genetic and cultural manipulations. This research has been highly successful in some cases, and it is expected that further success will be achieved. Scientists are also working on organisms essential to the growth of trees and by propagation may assist in achieving greater productivity.

Studies in Wisconsin on oak wilt have led to clarified information on infection processes, environmental effects and other aspects of the problem. Since young red oak are highly susceptible, research under controlled conditions has been possible. In one study, 1000 seedlings were inoculated, only nine survived and their resistance is being investigated. In Texas a cause of oak decline has been studied to determine the likelihood of possible control.

In Oregon research on one project has concentrated on finding resistance in root rot of Port-Oxford-Cedar. A more general program in Idaho has identified 54 major tree problems requiring action by managers. The shelterbelt region of South Dakota has required considerable attention to the development of methods for controlling damping-off. Several fungicides appear effective and other tests are continuing.

In Texas, a study of needle cast fungi shows that infection may relate to certain clones of the pine species as well as the natural moisture regime. At Fayetteville, Arkansas, virus diseases are being studied as they relate to forest stands. A virus on red cedar is apparently spreading and contributing to the slow death of the trees.

Research in Hawaii has concentrated in one study on natural antagonism of microbes. Evidence has been developed showing the role of inhibitors in reducing fungal spore germination in soil. Air pollutants have received attention in a number of studies. Studies in Michigan on London plane tree revealed significant damage after 25 ppm exposure to ozone for eight hours. This included reddening, watersoaking and necrosis.

—Fred B. Knight
Director, School of Forest Resources
University of Maine

Connecticut researchers are studying the virus infection of the fall cankerworm.

Relationship between forest cover and snowmelt are being studied in Pennsylvania.

Planning for Forestland Use

A major area of research in recent years and one receiving increasing emphasis is the planning of forestland use at various decision-making levels. This research focuses upon both decision processes and the data and information needed to make these decisions.

When planning for forestland use, it is necessary to recognize that the forest is an integral part of the economy and ecology of the nation. Most studies relate to the ecological (both human and non-human) linkages of the system and it is only the particular emphasis that tends to vary.

An increasing population with steady or increasing levels of affluence has put increasing pressure on the land base. Forestland has felt these pressures and the result has often been conversion to an alternative use. According to a recent U.S. Forest Service timber appraisal, the United States area of commercial timberland decreased by 8.44 million acres from 1962 to 1970. Although this is only a two percent decrease in commercial timberland area in less than a decade, it is still cause for concern.

The interests of society in the management of land resources, including forestland, revolve around the satisfaction of human wants, which is possible from production of goods and services requiring land as an input. Research in this area is carried out to provide results that assist decision-makers at many levels to make wise use of our forest resources. In some cases analytical models that can be applied by individual decision-makers to generate guidelines appropriate to a specific decision-making situation are developed. In other cases, information that can be used in the decision-making process to solve production and distribution problems is developed. Still another type of research output is the development of sampling plans and tools for collecting natural resource data that will assist decision-makers in their tasks.

Management Decision Processes

New Hampshire researchers reviewed the multiple-use decision-making process with foresters and forest economists. This review pointed to the factor of amenity values as the real unknown in decision-making. All those persons interviewed noted that it is essential to develop some method to evaluate combinations of market priced and non-market priced services and amenities.

Researchers in Virginia developed and tested a computer simulation model that provides answers to three important management questions: (1) what return can be expected from one rotation after planting loblolly pine? (2) what return can be expected from a series of possible rotations after planting loblolly pine? (3) what return can be expected from cutting an existing stand or letting it grow? Test results showed that planting loblolly pine for a 25-year rotation pays a 6.14% rate of return, holding a 15-year-old plantation to age 25 pays 7.11%, and holding a 15-year-old natural stand to age 20 pays 5.3%.

Mississippi scientists found that almost half of the state's non-industrial private forest landowners included in a study were using the land for purposes other than timber production and should be largely discounted for that commodity.

Colorado scientists have developed operational demographic models which are being linked to forest management decisions to provide estimates of impacts of forest management alternatives on population size and distribution. Another operational model developed in 1974 is a simple economic base formulation which utilizes census of population data. It provides a means of establishing a description of a region's economic structure and dynamics. This model in turn can be related to forest management alternatives.

Illinois researchers are developing a management planning system for the small woodlot owner. This system will have the capability of providing an evaluation of a forest stand that has been subjected to the effects of injurious agents. This system implements commonly used inventory methods and economic analyses to provide decision-making information.

West Virginia scientists have been investigating the effects of public involvement on federal land management decision-making. A land management plan utilizing public involvement in the goal development and decision-making process was located on the George Washington National Forest in Virginia. This plan involved use allocation for a unit plan and environmental impact statement and considered conflicting and diverse interests.

Land Use

A very important early decision that must be made before allocation decisions for goods and services production can be made involves allocation of land or space for specific activities and groups of activities.

As population increases and the land becomes more intensively developed, it is inevitable that linkages between the various human activities will become stronger. To investigate social gains and losses, it is necessary to analyze resource situations at levels larger than the individual decision-making unit but smaller than the national level.

Scientists in Indiana have been concerned with the community development program effects on land use. The major concentration of research activity has been centered on the rural/urban interface between the Louisville Metropolitan area and five Indiana counties which are rapidly being urbanized.

Also, Indiana researchers completed a natural resource study of the five-state Midlands area. This study examines forestry prospects, outdoor recreation, and the minerals industry with respect to change and development to the year 2000, taking into consideration certain cultural, demographic, and environmental variables.

Minnesota scientists have investigated criteria for evaluation of recreational projects. Results of the study indicate that state recreation planning presently does not include benefit-cost analysis, except in a few isolated instances, where the results are used more as supplemental information than as a direct input in the evaluation process.

Demand and Supply of Forestry Goods and Services

Demand and supply studies have traditionally been important information resources for economic planning in forestry. Two important subprojects in this category were completed in 1974 by California researchers. One is a provisional model for analyzing timber supply policy alternatives for a transitional period in California. The model presents a quantitative estimate of the 1970 timber resource in the state by type, site class, ownership, and stand character; it provides estimated costs of different future production alternatives and generates a timber supply function appropriate for the long term; projects prospective demand; and provides a basis for selecting an optimal timber supply program in light of that projection.

The second subproject consisted of a simulation model of the timber economy in Humboldt County, California. The model relates level of timber harvest to a) forest industry employment, b) total employment, and c) timber based tax revenues.

Researchers in Minnesota have completed development of projection equations for consumption and production in Minnesota and Wisconsin pulpwood markets for 1980, 1990 and 2000. Expected pulpwood production of 5.8 million cords was projected for 2000, which is more than a doubling of output in 30 years. Sustaining the timber resource at this level would be greatly dependent on intensification over present level of management practices. In addition, an update of 1962 allowable cut data for northern Minnesota forested counties showed a reduction of nearly one million acres of commercial forestland and a 22 percent decline in annual allowable cut.

Economics of Forest and Range Management

Planning of a forestry enterprise requires basic production data which can be analyzed with data for social and economic variables to develop guidelines for decision-making. Many projects in the research program fall into this category.

For example, investigators in Missouri conducted a study of black walnut multicropping. For the particular system studied the annual rate of return for the enterprise was 5.5 percent, whereas if land were handled as a separate investment the rate of return was 16 percent.

Researchers in Tennessee completed a study of epicormic branching in hardwood stands and found a high relationship between past or older branching and later branching following thinning treatment. Understocking may be of greater economic importance than the degrade directly related to thinnings by epicormics.

North Carolina researchers developed yield equations for natural stands on nine common southern hardwood site types, including: muck swamps, peat swamps, wet flats, red river bottoms, black river bottoms, branch bottoms, piedmont bottom lands, coves and lower mountain slopes, and upland slopes and ridges. The equations express yields in terms of green and dry weight which are most accurately correlated with pulp yields. Also, yield equations were developed for a variety of merchantibility standards ranging from conventional d.b.h. and top diameter limits for pulpwood and sawtimber to total biomass yields as would be realized from modern in-woods systems for total tree chipping.

Forest Land Taxation

A major force in determining trends in land use is the taxation policy pursued by the various levels of government. An important line of research, therefore, relates to the effects associated with alternative tax policies on land use, and on the production of forestry goods and services.

Investigators in Maryland conducted research to trace impacts of the state's Forest Conservation and Management Program. In that program, enacted in 1962, forest landowners may be eligible to receive "frozen" assessed valuations for property tax purposes on forestland, if they agree to place their tracts under a management program specified by the State Department of Forests. In spite of this opportunity, less than 7,000 acres of the more than two million acres in the state were placed in the program. A major deterrent to expansion in forest production in Maryland through application of intensive management practices has been the rapid increase in land values. This increase acts as a deterrent through increased capital requirements, higher interest payments and higher property taxes.

Data and Information Systems

Decision-making in forestry, as in any other line of enterprise, requires reliable data and information if goals are to be attained. Accordingly, several research projects focus on the problems relating to the design of data and information systems and procedures used in data processing.

A study conducted by researchers in Montana focused on the perceptions of state and federal land managers about the adequacy of information for decision making. A computerized literature review, which covered 1,600 pertinent forested habitat references on structure, function, and process was completed. Information deficiences in function and process were noted.

North Carolina researchers studied the relationship of plot size and configuration to precision of estimation of three characteristics for 21 southern pine stands ranging in age from 18 to 50 years. Results indicate that from the standpoint of precision, 1/5 acre square plots appear to be favored. Cost factors associated with data collection from the plot sizes and configurations considered will be obtained and used for comparison of relative efficiences.

Colorado researchers developed a computer mapping system which provides for assimilation and display of grid-based data. Data are entered into the system in two dimensional matrix form, combined as specified by the user, and displayed as printer-produced maps, microfilm and/or grayline and color maps (with the aid of a density slicer). The system has been tested using data from a 96 x 96 grid representing one township near Boulder, Colorado.

Michigan researchers completed a survey of selected natural resource information systems presently used by state agencies. These systems were surveyed from the viewpoint of their operational use in providing information such as that required by Federal and State environmental inpact studies.

New Jersey researchers completed analyses of the timber and vegetation inventories data of the 12,500-acre Stokes State Forest. A series of detailed overlay maps were prepared for the entire forest delineating the topography, major forest types and density of timber.

A technique for combining certain bio-physical environmental parameters with socio-economic characteristics and goals into planning units and performance standards for controlling land use has been developed by Cornell University researchers. Airphotos, soil survey maps, climate, Land Use and Natural Resources Inventory (LUNR, maps, farm variability classification, ownership data and ownership attitudes were the information base melded into planning divisions. This method is applicable in metropolitan hinterlands where vacation homes, agriculture and recreation are the dominant forms of land use, and where farm and forest land is being "invaded" by recreation homes.

Remote Sensing

California researchers continued work begun in 1973 on various kinds of space photography. Several California test sites were photographed on specific dates by the Skylab astronauts from an altitude of 275 miles, and on approximately the same dates, by both the Earth Resources Technology Satellite (ERTS-1), from an altitude of 570 miles and (by means of a U-2 aircraft) from an altitude of 65,000 feet. A comparative analysis of these photos was conducted to determine the optimum aerial and space photo specifications for use in making multiple resource inventories of wildland areas.

Purdue University researchers have continued biophysical research in remote sensing. Significant results have proved the effectiveness of using computer-aided analysis techniques on ERTS-1 satellite data, even in areas of mountainous terrain. Cover-type maps of coniferous forest, deciduous forest, grassland and cropland, bare rock and soil, and water were obtained by computer analysis for a 2,456,000 acre region in the Rocky Mountains. The cost of the analysis was approximately 0.1¢ per acre and the classification accuracy was over 90 percent.

ERTS data and computer analysis techniques also allowed more accurate maps of a burned-over forest area than had been operationally produced from aircraft scanner data. Although snow cover could not be spectrally differentiated from clouds on ERTS-1 data, multispectral scanner data from Skylab has proven the value of the middle infrared portion of the spectrum for differentiating snow. These results have tremendous potential economic significance for more effective predictions of water runoff in many of the mountainous regions of the world.

In contrast to these results, Michigan researchers, in applications of remote sensing to forest inventory, found that little information about composition of forest stands could be gleaned from ERTS-1 satellite data. ERTS-1 data were found useful for identifying and mapping large forest stands. Computer analysis of the ERTS data in digital form gives better results but is more expensive than photo-interpretation of ERTS transparencies. Photo-interpretation of high resolution Skylab imagery gave good results in indentifying and mapping woodlots as small as one hectare. Even with this imagery, however, analysis of composition within stands is difficult. A demonstration project in Mason County, Michigan has shown color-infrared photos at a scale of approximately two inches to the mile to be suitable for preparing forest type maps with broad classifications of species, stocking, and maturity.

Minnesota researchers found that application of ERTS imagery to the state's forest classification (visual interpretation of combined and density-sliced imagery) had limited success in forest species identification. However, small format aerial photography of various types, both in Montanna and Minnesota, provided indications of an increasing number of applications which could be accomplished at the local level at minimum cost.

Analysis of Government Programs

Vermont researchers conducted a study of Youth Conservation Programs. An analysis of average accomplishments per youth hour of work on 43 categories of work, along with a measure of the variance that was experienced, was compiled for use in planning work for future camps.

Minnesota researchers completed the first phase of a study of the Rural Environmental Assistance Program, Practice A7 in the state. Results indicate that the method developed for analyzing the private forest landowner's need for incentive monies could be used to increase the effectiveness of the 1973 Farm Bill Forestry Incentives Program (FIP) and to increase overall efficiency of investments in private non-industrial forestry.

—Daniel E. Chappelle
Department of Forestry
Michigan State University

Radio transmitters track the feral hog.

Pinion-juniper and oak brush offer invaluable wildlife habitat and have high aesthetic value.

Yellow poplar seedlings made good growth on Alabama mine spoils treated with lime, N, P, and K.

Training Research Workers

The Congressional Act establishing the McIntire-Stennis Cooperative Forestry Research Program states . . . "that forestry schools are especially vital in the training of research workers in forestry."

One of the goals of this research program is to provide the resources in a variety of forms for young researchers to draw upon in the research component of their academic experience. When this program was conceived, there was no way to predict either the coming of the new era of environmental awareness or that the pressure on renewable resources would mount so fast. This development was brought into clear focus as the finiteness of fossil energy sources was fully realized. Forest resources, unlike oil, coal, aluminum and other finite resources, should never run out.

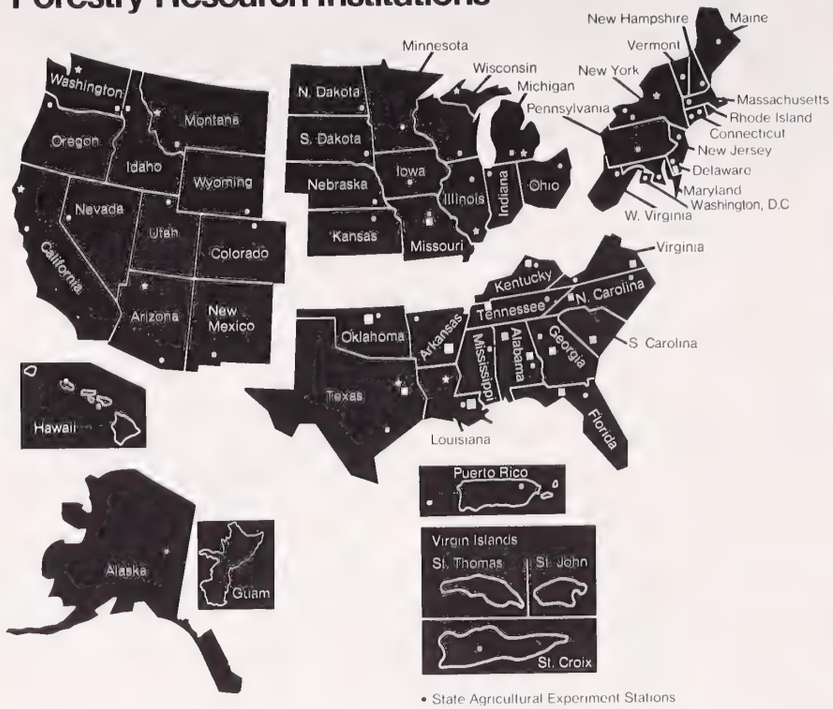
A major way to prevent forest resources crises is to continue a strong program of research that will assure sustained development of highly motivated students into productive researchers. This approach will also contribute to aiding the supply of stimulated forestry researcher-educators. The McIntire-Stennis program has allowed research programs to operate at a new level of graduate student involvement and to sustain the supply of new Ph.D. research workers.

Research projects supported by the McIntire-Stennis program continue to constitute the resource material for research by graduate students in an array of areas (Table 1). These data show that the major emphasis is on "Renewing the Timber Supply". About 200 students are researching this topic, while just over 100 are researching utilization. A desirable balance of effort is apparent.

Table 1. Graduate Students using McIntire-Stennis Research Projects (1975).

Program Area	Projects	Graduate Students
	number	
Renewing Timber Supply	204	206
Protecting Watersheds	49	50
Forage and Habitat	52	87
Recreation	33	33
Utilizing Wood Resources	120	129
Protecting Forest Resources	85	78
Planning for Forest Land Use	38	43
Innovative Application, Urban Forestry	—	—
Total	597	641

State Agricultural and Forestry Research Institutions



• State Agricultural Experiment Stations
★ Cooperating Forestry Schools
■ Colleges of 1890 (including Tuskegee Institute)

A 1973–74 ASCUFRO study revealed that nationwide the need by member-institutions for Ph.D. level scientist-educators was for nearly 100 new faculty. This represents about three-fourths of the total Ph.D.'s conferred. A study conducted in 1973 by ASCUFRO revealed that its member institutions employed less than half the researchers trained in the McIntire-Stennis program. Over half were employed by industry, federal agencies and others. Thus, it appears that the demand for well-trained researchers will remain strong and should continue as an important trust of the program.

—Wayne Smith
School of Forest Resources and Conservation
University of Florida

Participating Institutions

Institution	Location	Administrative Technical Representative	Forestry Representative
Auburn Univ.	Auburn, AL	R. D. Rouse	W. B. DeVall
Univ. of Alaska	Fairbanks, AK	J. V. Drew	J. V. Drew
Northern Ariz. Univ.	Flagstaff, AZ	C. O. Minor	C. O. Minor
Univ. of Arizona	Tucson, AZ	G. R. Stairs	D. B. Thorud
Univ. of Arkansas	Fayetteville, AK	L. O. Warren	G. A. Bradley
Univ. of Calif.	Berkeley, CA	J. B. Kendrick, Jr.	W. E. Waters
Calif. State Univ.—Humboldt	Arcata, CA	G. Partain	G. Partain
Colorado State Univ.	Ft. Collins, CO	R. E. Dils	R. E. Dils
Connecticut Agr. Exp. Sta.	New Haven, CT.	P. E. Waggoner	P. E. Waggoner
Univ. of Connecticut	Storrs, CT	J. J. Lucas	J. J. Lucas
Univ. of Delaware	Newark, DE	W. E. McDaniel	W. E McDaniel
Univ. of Florida	Gainesville, FL	J. W. Sites	J. G. Gray
Univ. of Georgia	Athens, GA	A. M. Herrick	A. M. Herrick
Univ. of Guam	Agana, Guam	W. P. L. Guerrero	W. P. L. Guerrero
Univ. of Hawaii	Honolulu, HI	W. R. Furtick	N. P. Kefford
Univ. of Idaho	Moscow, ID	J. H. Ehrenreich	J. D. Ehenreich
Univ. of Illinois	Urbana, IL	G. W. Salisbury	I. D. Holland
Southern Illinois Univ.	Carbondale, IL	H. A. Spalt	H. A. Spalt
Purdue Univ.	Lafayette, IN	B. J. Liska	M. C. Carter
Iowa State Univ.	Ames, IA	J. P. Mahlstede	G. W. Thomson
Kansas State Univ.	Manhattan, KS	F. W. Smith	R. W. Campbell
Univ. of Kentucky	Lexington, KY	C. O. Little	T. Hansbrough
Louisianna State Univ.	Baton Rouge, LA	D. Chambers	P. Y. Burns
Louisiana Tech Univ.	Ruston, LA	J. L. Teate	J. L. Teate
Univ. of Maine	Orono, ME	K. E. Wing	F. B. Knight
Univ. of Maryland	College Park, MD	J. Turnbull	J. Turnbull
Univ. of Massachusetts	Amherst, MA	R. S. Whaley	D. R. Progulske
Univ. of Michigan	Ann Arbor, MI	W. J. Johnson	J. R. Bassett
Michigan State Univ.	East Lansing, MI	S. H. Wittwer	L. M. James
Michigan Technological Univ.	Houghton, MI	G. A. Hesterberg	G. A. Hesterberg
Univ. of Minnesota	St. Paul, MN	K. A. Huston	R. A. Skok
Mississippi State Univ.	Miss. State, MS	R. R. Foil	R. F. Wambach
Univ. of Missouri	Columbia, MO	R. J. Aldrich	E. L. Miller
Univ. of Montana	Missoula, MT	R. F. Wambach	M. L. Wilson
Montana State Univ.	Bozeman, MT	J. A. Asleson	E. L. Ellwood
Univ. of Nebraska	Lincoln, NB	H. W. Ottoson	J. E. Langwig
Univ. of Nevada	Reno, NV	D. W. Bohmont	L. F. Martorell
Univ. of New Hampshire	Durham, NH	H. A. Keener	R. M. Peterson
Rutgers—The State Univ.	New Brunswick, NJ	W. A. Walton	L. C. Walker
New Mexico State Univ.	Las Cruces, NM	L. S. Pope	J. F. Hosner
State Univ. of New York	Syracuse, NY	R. E. Pentoney	G. A. Harris
			L. I. Painter

Cornell Univ.	Ithaca, NY	N. L. VanDemark	R. R. Foil
N.C. State Univ.	Raleigh, NC	E. L. Ellwood	F. G. Payne
N.D. State Univ.	Fargo, ND	A. G. Hazen	B. B. Foster
Ohio Agr. Research & Development Cntr.	Columbus, OH	R. M. Kottman	C. C. Larson E. P. Lana
Oklahoma State Univ.	Stillwater, OK	F. H. Baker	R. M. Kallander
Oregon State Univ.	Corvallis, OR	C. H. Stoltenberg	W. P. Gould
Penn. State Univ.	Univ. Park, PA	W. I. Thomas	J. W. Barrett
Univ. of Puerto Rico	Rio Piedras, PR	M. Perez-Eslolar	L. S. Davis
Univ. of R.I.	Kingston, RI	G. A. Donovan	
Clemson Univ.	Clemson, SC	W. H. Davis McGregor	W. W. Christensen
S. D. State Univ.	Brookings, SD	R. A. Moore	
Univ. of Tenn.	Knoxville, TN	D. M. Gossett	
Texas A&M Univ.	College Station, TX	J. E. Miller	D. P. Duncan
Stephen F. Austin State University	Nacogdoches, TX	L. C. Walker	M. D. Ferrill
Utah State Univ.	Logan, UT	T. W. Box	R. F. West
Univ. of Vermont	Burlington, VT	H. John	L. S. Hamilton
Va. Polytechnic Inst. & State Univ.	Blacksburg, VA	C. T. Wilson	G. E. Gatherum
College of the Virgin Islands	St. Croix Campus, Virgin Island	O. S. Padda	W. K. Murphy
Univ. of Washington	Seattle, WA	J. S. Bethel	R. M. Allen
Washington State Univ.	Pullman, WA	J. Nielson	R. G. Merrifield
West Virginia Univ.	Morgantown, WV	D. W. Zinn	H. John
Univ. of Wisconsin	Madison, WI	S. C. Smith	S. P. Gessell
Univ. of Wyoming	Laramie, WY	N. W. Hilston	R. L. Giese

Current Research Effort

Cooperative Forestry Research Program efforts in FY 1975 are distributed within the four regions of the Association of State College and University Forestry Research Organizations (ASCUFRO). The data represent the total cooperative Forestry Research Program, which includes McIntire-Stennis, Hatch and Non-Federal research.

The program is guided by continuous regional and national planning by heads of ASCUFRO units and representatives of the U. S. Department of Agriculture. Assistance is provided in the planning process by non-participating schools of forestries, private industry, and other agencies with forestry research interests. Task forces within the research groups, made up of scientists, administrators and other contributors from the several states of a region, identify research needs on a priority basis. Thus, the Cooperative Forestry Research Program can be responsive to local and regional needs.

In 1976, task forces within all four regions will complete reports which will be drawn upon for the development of a National Program for Forest Resources Research. The national program development will receive special attention from the Cooperative State Research Service and the Forest Service in close working relationships with ASCUFRO. Periodic reports on the Cooperative Forestry Research Program can be expected to reflect changes in the research effort at the cooperating institutions by program groups and regions in response to the results of these analyses of research needs and identification of priorities.

—Aubrey E. Wylie
Cooperative State Research Service
U.S. Department of Agriculture

Forest openings and parks are important to the maintenance of wildlife and, likewise have high value for recreation and provide a pleasing and diverse landscape.

McIntire-Stennis Cooperative Forestry Research Effort in 1975 by Region[1]

Research Programs	Region									
	Northeast		South		North Central		West		National	
	SY's	%	SY's	%	SY's	%	SY's	%	SY's	%
Inventory and Appraisal (forest, range and remote sensing)	2.0	2.0	6.6	4.4	6.4	6.3	9.2	7.1	24.2	5.0
Timber Management (biology, culture, management, tree improvement)	19.5	19.6	54.0	36.2	35.7	34.8	32.2	24.7	141.4	29.4
Forest Protection (insects, diseases, fire)	20.8	20.9	28.1	18.8	13.5	13.1	18.3	14.0	80.7	16.8
Harvesting, Processing and Marketing (engineering, production, product development, marketing, grades, demand and housing)	30.5	30.7	33.6	22.5	26.2	25.2	33.9	26.0	124.2	25.8
Watersheds, Soils, Pollution (soil inventory soil/plant/water nutrient relations, watershed protection, water use, pollution abatement)	5.7	5.7	6.4	4.3	9.8	9.4	11.6	8.9	33.5	6.9
Range, Wildlife, and Fishery Resources (habitat interactions, quality, and management)	6.8	6.9	12.8	8.6	1.2	1.2	12.2	9.4	33.0	6.9
Forest Recreation and Aesthetics (demand, planning allocation, management)	6.0	6.1	4.5	3.0	6.8	6.6	5,9	4.6	23.2	4.8
Forest Land Use (alternatives multiple-use)	8.0	8.1	3.2	2.2	3.2	3.1	6.9	5.3	21.3	4.4
TOTAL	99.3	100.0	149.2	100.0	102.8	100.0	130.2	100.0	481.5	100.0

[1] Represents all McIntire-Stennis, Hatch, and Non-Federal research in forestry reported by participating institutions.